

ENVIRONMENTAL SITE ASSESSMENT AND GROUND WATER MONITORING

Federal Center South
4735 East Marginal Way South
Seattle, Washington

Prepared for

U.S. General Services Administration
10PCA, 400 15th Street Southwest
Auburn, Washington 98001

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Prepared by

Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 601
Seattle, Washington 98121
Telephone: 206/441-9080

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Work for these investigations were performed in accordance with applicable planning documents and generally accepted professional standards and practices for the type of work performed. While information regarding subsurface conditions, including soil and ground water quality, is believed to be generally representative of conditions at the site, conditions may change within short distances. Additional subsurface materials and contaminants may be present at locations not investigated during this study.

Executive Summary

This report presents results and documents site conditions discovered during site assessments associated with underground tank removal at the Federal Center South facility located in Seattle, Washington. Following tank and contaminated soil removal, an initial site investigation, additional removal of contaminated soil, and a follow-up site investigation were conducted at the site. Limited exploration during the tank removal process indicated a gasoline release beneath a former fuel dispenser unit, extending approximately 30 feet to the south and west.

Approximately 100 feet south of the gasoline tank, a waste oil tank also was found to have released diesel and heavy oil to soil immediately surrounding the tank.

The Federal Center South facility is located at 4735 East Marginal Way South (Figure 1), along the eastern riverbank of the Duwamish Waterway within the industrial portion of South Seattle. The removed tanks included a 12,000-gallon gasoline tank used to provide fuel for motor pool vehicles and a 1,000-gallon waste oil tank used for storage of fluids resulting from motor pool vehicle maintenance. Both tanks were registered with the Washington Department of Ecology (Ecology).

The initial investigation included subsurface soil and ground water sampling at 15 locations surrounding the 12,000-gallon gasoline tank and 1,000-gallon waste oil tank to the south. Sampling indicated gasoline free product approximately 15 feet south of the previous tank excavation, with evidence of contaminated soil extending another 20 feet. Contamination at the waste oil tank appeared to be limited adjacent to the tank. Further excavation of contaminated soil was completed above the water table in both areas and seven monitoring wells were installed to determine extent of contaminant migration and ground water flow characteristics. Ground water monitoring was initiated, with flow direction determined to be west-southwest and contamination found to be limited to near the tanks. Ground water monitoring will continue on a quarterly basis to determine the effectiveness of source removal and contaminant migration characteristics.

Site Background

Site Location and Description

The Federal Center South facility is located at 4735 East Marginal Way South in Seattle, Washington (Figure 1). The subject site is located in King County, in the NW $\frac{1}{4}$ of the NE $\frac{1}{4}$ of section 19, township 24 north, range 4 east from the Willamette Meridian (USGS 1983). The site is bounded by commercial and industrial properties to the north, the Duwamish Waterway to the west, and office and warehouse buildings housing several federal agencies to the south and east.

The site is approximately 5 to 10 feet above mean sea level, consisting of a relatively level concrete/asphalt parking lot and several multi-story office and warehouse buildings. No soil is exposed to the surface at any place in the site vicinity. The layout of the former tanks and surrounding site features pertinent to this project are shown in Figures 2 and 3. The waste oil tank was located immediately adjacent to the west side of building 12.03, and the gasoline tank was located approximately 20 feet west of the same building. The former waste oil tank was used for disposal of fluids during motor pool vehicle maintenance, and the gasoline tank was used to provide fuel for motor pool vehicles. The dispenser was removed from the south end of the tank when service ended in the late 1980s.

Both tanks were registered with the Washington state Department of Ecology (Ecology) associated with site identification number 10042. According to U.S. General Services Administration information, tank T7 was used until the early 1990s, and tank T8 was removed from service in the late 1980s. No other potential sources for hazardous substances were identified at the site.

The contamination investigation was initiated as a result of encountering petroleum hydrocarbon contamination in soil surrounding the gasoline and waste oil tanks during tank removal and decommissioning activities conducted in May 1998. An initial investigation was conducted at the time of tank removal by digging test pits to the south and west of the gasoline tank (Herrera 1999). A follow-up investigation was conducted in August 1998 following tank closure, which included soil and ground water sampling at 15 boring locations across the site using the push probe drilling method. Based on the results of these field efforts, additional excavation and removal of petroleum-contaminated soil at the south end of the gasoline tank and immediately west of the waste oil tank was conducted in April 1999. In June 1999, seven monitoring wells were installed and ground water samples collected as part of the beginning of a ground water monitoring program implemented at the site.



Figure 1. Location map, Federal Center South, Seattle, Washington.

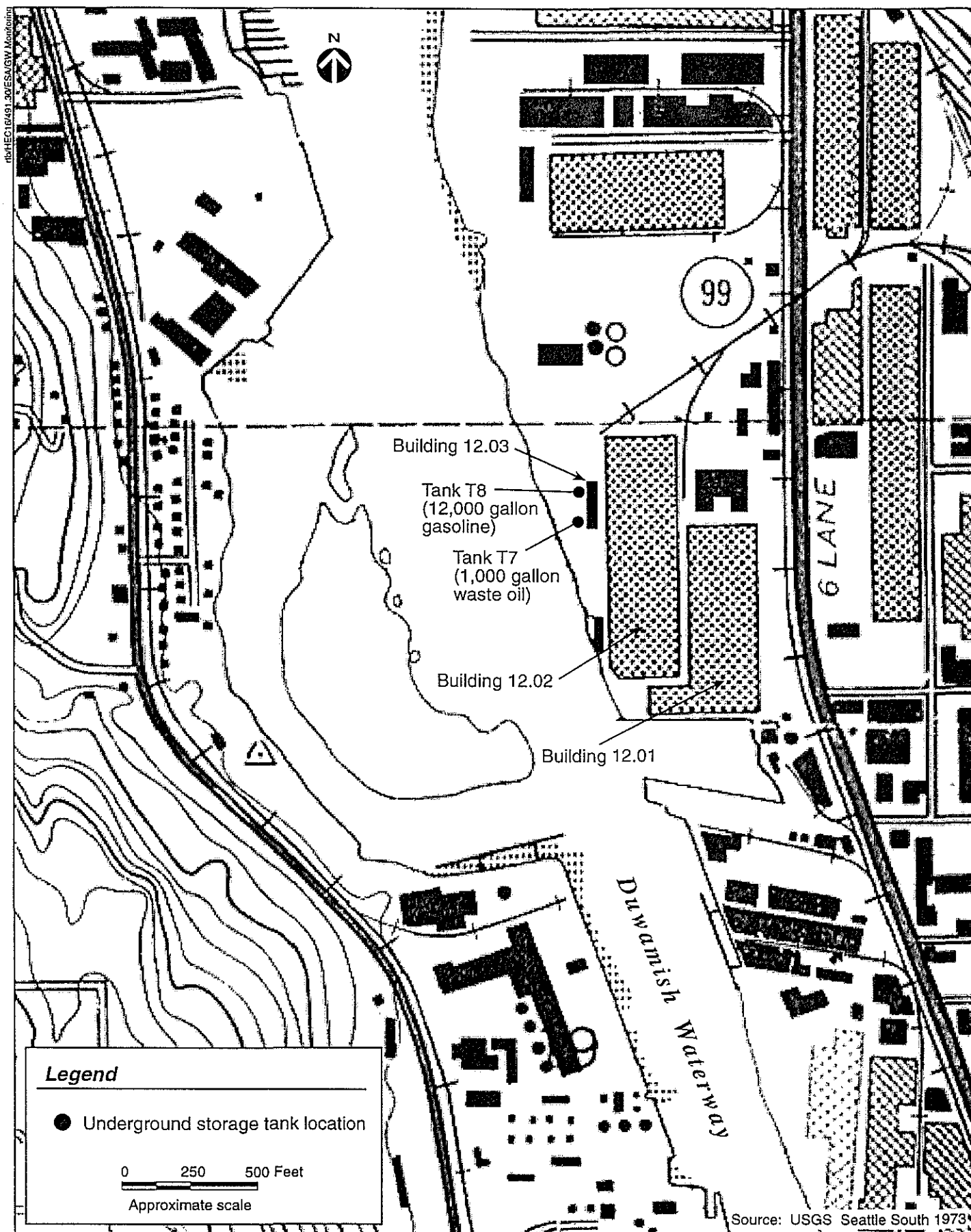
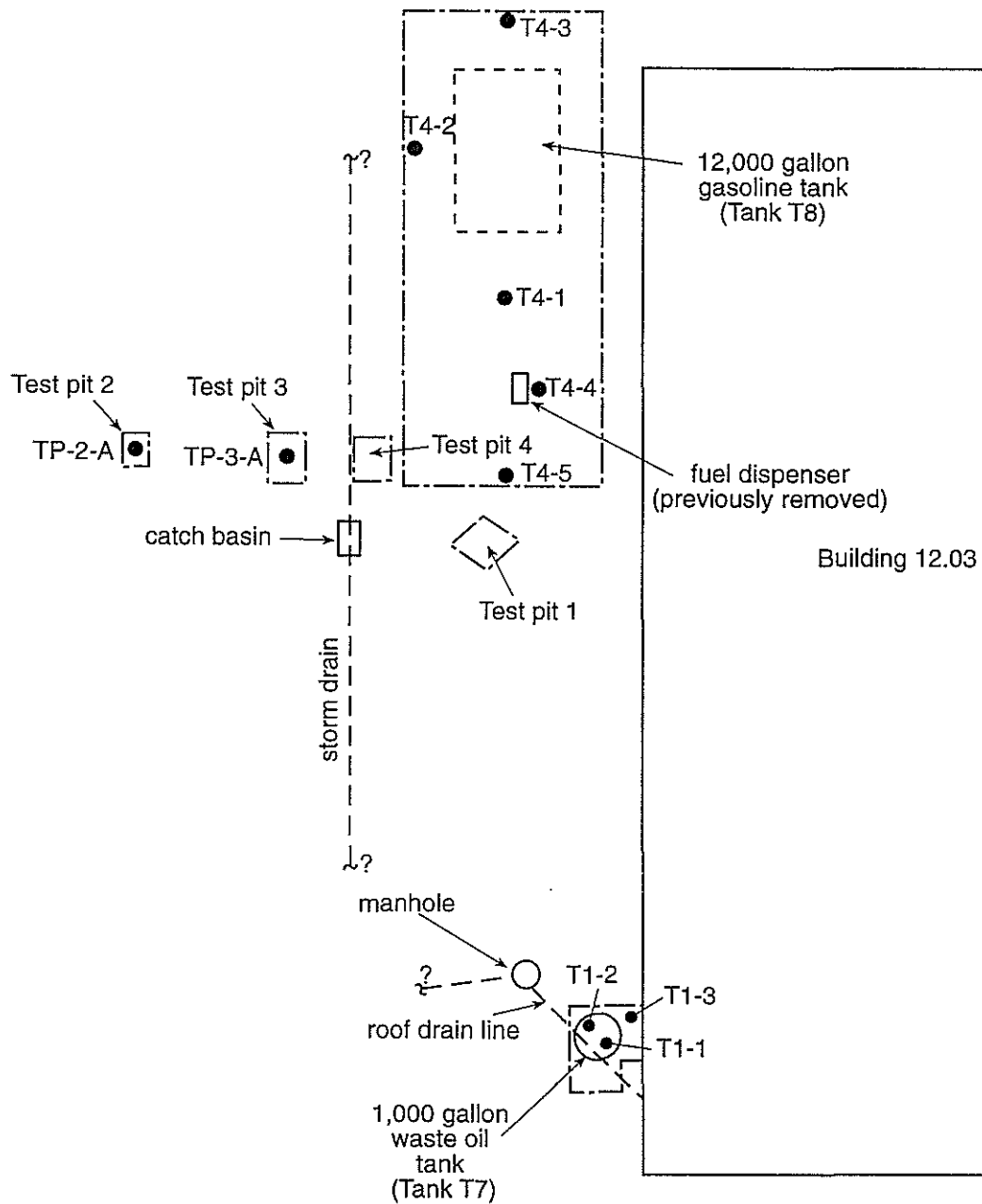


Figure 2. Site location map, Federal Center South, Seattle, Washington.



Legend

- T4 -1 ● Soil sample location
- Limits of excavation

0 30 feet
Approximate scale

| Sample # | Depth | Sample # | Depth |
|----------|-------|----------|-------|
| T1-1 | 8.5 | T4-5 | 5' |
| T1-2 | 8.5 | TP-2-A | 5.5' |
| T1-3 | 8.5 | TP-3-A | 5.5' |
| T4-1 | 5.4' | | |
| T4-2 | 5.4' | | |
| T4-3 | 5.4' | | |
| T4-4 | 2.5' | | |

Source:
GSA Public Buildings Service -
UST Removal/Abandonment/
Replacement and AST Installation -
6/14/96 Drawing C-4.



Figure 3. Former waste oil tank T7 and gasoline tank T8 location map, Building 12.03 at Federal Center South, Seattle, Washington.

Geology and Hydrogeology

The Federal Center South site is situated within the Duwamish River Valley of the Puget Lowland physiographic region in Washington state. During the Pleistocene Epoch, the Puget Lowland underwent extensive and repeated glaciation. Generally, an ice sheet known as the Puget Lobe migrated southward from Canada into the Puget Lowland. Many present-day features and landforms are the result of ice scouring and deposition of glacial debris. As the glacial ice retreated in the late Pleistocene, thick sequences of glaciofluvial outwash and till, known as the Vashon Drift, were deposited. Recent fluvial deposits locally overlie glacial deposits from northwest-trending streams and rivers.

The Duwamish River valley is a north-trending trough situated between rounded hills composed almost exclusively of glacial deposits. The deposits observed and mapped along the river bank in this area consist of post-glacial alluvial deposits of an interlayered series of silt, sand, gravel, and organic material. The alluvial deposits in the Duwamish Valley are more than 100 feet thick and are intercalated with marine embayment sediments of sand and silt (Galster 1991). Isolated pockets of peat and other organic material also are present in areas of accumulation in old meander channels and other depressions. Soils encountered during subsurface investigations conducted at the site consisted of alluvial deposits of silt with clay and organic material overlain by a medium- to coarse-grained sand layer. Much of the Duwamish River valley has been developed and modified using artificial fill consisting of mainly sediments of sand and silt. This fill material ranges in depth from less than 5 feet to more than 50 feet in old river channels. The Federal Center South site includes a top layer of fill material overlying the alluvial sand layer. This was found in portions of the site consisting primarily of sand with variable amounts of gravel ranging between 1 and 7 feet thick.

The site is situated along the east bank of the Duwamish Waterway, with the nearest tank approximately 100 feet east of the river bank, at an approximate elevation of 5 to 10 feet above mean sea level (USGS 1983). The topography of the site is relatively flat, with a slight gradual slope down to the west. Ground water encountered during drilling onsite ranged from 6.5 to 14 feet below ground surface. Ground water monitoring data has been collected from seven monitoring wells installed onsite, FC-1 through FC-7. Ground water surface elevation contours interpreted from monitoring data indicate that the shallow ground water flow direction generally is to the west-southwest toward the Duwamish Waterway, at an average hydraulic gradient of less than 0.01 feet per foot.

Direct infiltration and seepage from surface waters, precipitation, and surface runoff primarily recharges ground water in this area. The Federal Center South facility currently receives drinking water from the city of Seattle municipal water supply. Ground water beneath the site is not known to be used by the facility.

Tank Removal

In May 1998, EP Johnson Construction & Environmental (E.P. Johnson) of Pasco, Washington conducted underground storage tank decommissioning and closure activities at the Federal Center South facility. The tank removal process occurred over a three-day period from May 19 to May 21, 1998 with additional excavation of contaminated soil on May 27, 1998. The tanks removed from the site included:

- Tank T7—a spherical fiberglass UST seven feet in diameter, located immediately adjacent to the west side of building 12.03 (motor pool), beneath concrete paving (Figure 3). The 1,000-gallon former waste-oil tank was used by the motor pool for disposal of fluids during vehicle maintenance.
- Tank T8—a single-shelled steel UST, was located about 20 feet west of building 12.03, beneath concrete paving (Figure 5). The 12,000-gallon former gasoline tank provided fuel for motor pool vehicles. The tank measured 28 feet in length, with a diameter of eight feet. Piping consisted of a supply line that ran from the tank to the pump dispenser located about 12 feet south of the tank.

On May 19th, the tanks were inerted, the overlying soils removed from the top of the tanks, and remaining product pumped from the tanks. At tank location T8, soil contamination was evident near the dispenser piping. Holes were found in the suction piping, which ran about 15 feet from the tank to the dispenser. A petroleum odor was evident and a sheen was present on the water surface in the excavation after the tank was removed. About 80 cubic yards of contaminated soil was removed from the excavation and stockpiled immediately to the west. The final dimensions of the excavation measured 43 feet by 18 feet to a depth of about 7 feet below ground surface.

On May 20th the fuel dispenser area immediately south of tank T8 was overexcavated. The final dimensions of this excavation were about 23 feet by 18 feet to a depth of 5 feet below ground surface. On May 21, 1998, four test pits were excavated west of the dispenser excavation and samples collected to determine the extent of contamination in the fuel dispenser area.

About 10 cubic yards of contaminated soil were removed from the excavation at tank T7. Because this tank was initially to be closed in place, the tank was emptied and cleaned, then holes were drilled through the bottom, and samples collected about 10 inches below the tank. Samples also were collected from beneath the piping run. Stained soil was present beneath the tank, and it was determined that removal would not compromise the foundation of the adjacent building. Therefore, the fiberglass tank was removed, cleaned, and disposed of with other refuse from Federal Center South on May 21, 1998.

Results of two samples collected through the bottom of waste oil tank T7 indicated diesel-range hydrocarbon concentrations (4,000 mg/kg and 4,700 mg/kg) and heavy oil-range hydrocarbon concentrations (11,000 mg/kg and 12,000 mg/kg) exceeding MTCA method A cleanup criteria

(Figure 3). The sample collected beneath the fuel pipe had a heavy oil-range concentration (360 mg/kg) exceeding the MTCA cleanup criterion. The MTCA method A cleanup criteria for heavy metals were not exceeded in any of the samples submitted for this analysis.

Based on the diesel and heavy oil concentrations above regulatory cleanup levels found in this excavation, additional excavation and removal of contaminated soil was conducted later in April 1999 (see following section, Additional Soil Excavation).

Results of samples collected from the south, west, and north sides of gasoline tank T8 indicated gasoline-range hydrocarbons to the north with a concentration of 350 mg/kg, exceeding the MTCA method A cleanup level of 100 mg/kg (Figure 3). No gasoline constituents were detected above practical quantitation limits in the south or west side samples.

Results of two samples collected from the fuel dispenser area indicated gasoline-range hydrocarbons at concentrations of 120 and 700 mg/kg, both above the MTCA method A cleanup criterion. BTEX constituents also were detected in both samples, but only the xylenes concentration in one sample (66 mg/kg) exceeded the MTCA cleanup criterion.

No gasoline constituents were detected above practical quantitation limits from samples collected at two test pits excavated west of the dispenser area.

Total lead concentrations ranged from non-detect to 31 mg/kg in twelve samples collected during Tank T8 removal and from non-detect to 28 mg/kg in three samples collected at Tank T7. All results were below the MTCA method A soil cleanup level for lead at 250 mg/kg.

Because concentrations of gasoline-range hydrocarbons and xylenes exceeded cleanup criteria at the water table, particularly in the dispenser area, additional excavation and removal of contaminated soil was conducted later at the site in April 1999 (see following section Additional Soil Excavation).

Excavated Soil Disposal

Stockpiles of excavated soil from both tank excavations were sampled and found to contain petroleum hydrocarbon concentrations exceeding the MTCA cleanup criteria. Both stockpiles were hauled offsite for disposal by Remedco, Inc. Environmental Services of Seattle, Washington.

Initial Site Investigation Summary

In August 1998, following tank removal and closure assessment, a site investigation was initiated to further determine the extent of petroleum hydrocarbon contamination of soil and ground water downgradient from the former gasoline tank, waste oil tank, and fuel dispenser area. This site investigation was conducted to determine the need for further contaminated soil removal, and to determine the number and positions of monitoring wells to be installed for long-term monitoring. The site investigation consisted of drilling and collecting soil and ground water samples for chemical analysis at 15 locations across the impacted area using the push probe drilling method.

A detailed description of field procedures, including sample collection, handling, decontamination, and drilling, is presented in Appendix A of this report. Boring logs for all drilled holes are provided in Appendix B. Laboratory analytical reports for samples collected during the site investigation are provided in Appendix C. Photographic documentation of drilling activities and the site is provided in Appendix D.

Drilling and sampling activities were conducted on August 11, 1998. Herrera Environmental Consultants, Inc. collected soil and ground water samples for chemical analysis. Cascade Drilling, Inc. of Woodinville, Washington provided push probe drilling services, and OnSite Environmental Inc. of Redmond, Washington analyzed the samples for petroleum hydrocarbon constituents. Results of this investigation are described in the following sections.

Drilling and Sampling Procedures

The field investigation conducted at Federal Center South consisted of drilling and sampling soil and ground water from 15 push probe boring locations (GP-1 through GP-15; see Figure 4). Probe boring locations GP-1 through GP-3 were located to sample soil to the north and west, downgradient from gasoline tank T8. Probe boring locations GP-4 through GP-6 were located to sample soil and ground water near the former fuel dispenser. Probe boring locations GP-7 through GP-15 were located to assess soil and ground water quality for petroleum contaminants associated with waste oil tank T7.



Legend

GP-1 ● Probe boring locations

GP-11
Benzene 2.5
TEX/TPH-G ND
Ground water results reported in µg/L

GP-1
BTEX/TPH-G ND
Soil results reported in mg/kg on a dry weight basis

| GP-4 | |
|--------------|-----|
| Benzene | 13 |
| Toluene | ND |
| Ethylbenzene | ND |
| Xylenes | 1.2 |
| TPH-G | 130 |

| GP-11 | |
|-----------|-----|
| Benzene | 2.5 |
| TEX/TPH-G | ND |

| GP-8 | |
|------------|-----|
| BTEX/TPH-G | ND |
| Diesel | 400 |
| Heavy oil | ND |

| GP-9 | |
|-----------|-----|
| Benzene | 3.7 |
| TEX/TPH-G | ND |

| GP-10 | |
|------------|----|
| BTEX/TPH-G | ND |

| GP-10 | |
|------------|----|
| BTEX/TPH-G | ND |

| GP-14 | |
|-----------|-----|
| Diesel | ND |
| Heavy oil | ND |
| VOC | ND |
| PAH | ND |
| PCB | ND |
| Cr | 6.1 |
| Zn | 12 |

| GP-7 | |
|------------|-----|
| BTEX/TPH-G | ND |
| Diesel | 68 |
| Heavy oil | 170 |

| GP-13 | |
|-----------|----|
| Diesel | ND |
| Heavy oil | ND |

| GP-12 | |
|-----------|-----|
| Diesel | ND |
| Heavy oil | 130 |
| VOC | ND |
| PAH | ND |
| Cr | 6.5 |
| Zn | 23 |

| GP-15 | |
|-----------|----|
| Diesel | ND |
| Heavy oil | ND |

0 30 feet

Approximate scale

Note: Ground water encountered from 6-7 feet below ground surface.



Figure 4. Analytical results from probe borings at Federal Center South, Seattle, Washington.

Soil Sample Collection from Push Probe Borings

All 15 probe borings were drilled and sampled on August 11, 1998. Each probe boring was driven to a maximum depth ranging from 7 to 9 feet below ground surface. Soil samples were collected continuously at 2-foot depth intervals until ground water was encountered at approximately 6.5 feet below ground surface. Soil samples were retrieved using a decontaminated push drive soil-sampling probe. Soil samples were visually classified for lithologies, screened for the presence of volatile organic compounds using a photoionization detector, and observed for moisture content indicating the presence of ground water.

Based on field screening results, soil samples collected across the water table at seven probe boring locations (GP-1, GP-7, GP-8, GP-10, GP-12, GP-13, and GP-14) were stored in chilled coolers and submitted under chain-of-custody protocol to the laboratory for chemical analysis.

Ground Water Sample Collection from Push Probe Borings

Ground water samples were collected from five probe boring locations (GP-4, GP-9, GP-10, GP-11, and GP-15) drilled downgradient of the impacted areas relative to the assumed ground water flow direction. Samples were collected by driving a sealed stainless steel screened well point to the desired depth, opening the screen, and obtaining a water sample via dedicated tubing and peristaltic pump at the surface. Depth to water was determined by the field geologist based on observations of soil moisture content. Water samples were collected directly from the tubing into sample containers provided by the laboratory. Care was taken to ensure that no bubbles or headspace were present in the containers. Immediately upon filling, each container was securely capped, labeled, and placed in a chilled cooler for storage prior to delivery to the laboratory for analysis.

After soil and ground water samples were collected, boreholes were backfilled with bentonite chips, then sealed at the surface with asphalt.

Sample Analyses

The eight soil samples collected from probe borings located across the study area were analyzed for the presence of gasoline-range hydrocarbons using Ecology's NWTPH-G test method and BTEX constituents using U.S. EPA test method 8021. Samples collected from probe boring locations drilled in the vicinity of the waste oil tank T7 also were analyzed for the presence of diesel- and heavy oil-range hydrocarbons using Ecology's NWTPH-DX method. In addition to the petroleum hydrocarbon analyses, soil samples collected from probe borings GP-12 and GP-14 were analyzed for waste oil parameters including:

- Volatile organic compounds (VOCs) using U.S. EPA test method 8260
- Polynuclear aromatic hydrocarbons (PAHs) using U.S. EPA test method 8270

- Polychlorinated biphenyls (PCBs) using U.S. EPA test method 8082 (only analyzed on the sample from GP-14)
- Total metals for chromium and zinc using U.S. EPA test method 6010 (total RCRA metals analyses results for samples collected during tank removal did not indicate elevated concentrations of any constituent).

Water samples collected from probe borings GP-4, GP-9, GP-10, and GP-11 were submitted to the laboratory for gasoline-range hydrocarbon analysis using Ecology's NWTPH-G test method and BTEX constituents using U.S. EPA method 8021. The sample collected from probe boring GP-15 was analyzed for the presence of diesel- and heavy oil-range hydrocarbons using Ecology's NWTPH-DX test method.

Complete laboratory analytical packages for both soil and ground water samples, including sample chain-of-custody forms, are presented in Appendix C of this report.

Data Quality Assurance Review

The analysis of seven soil samples and six water samples for petroleum hydrocarbons and BTEX constituents was determined to be acceptable for use based on the following criteria:

Method Blanks—Methylene chloride, a common laboratory solvent, was detected at low concentrations in the method blank quality control sample, as well as in two soil samples analyzed for VOCs. No other contaminants were detected in any of the method blanks above the instrument detection limits.

Surrogate Recoveries—All of the undiluted samples had percent recoveries of surrogate compounds within acceptable control limit ranges.

Laboratory Control Spiked Samples—The lab analyzed spiked samples for diesel, and the percent recoveries for soil samples (84-85 percent) and water samples (91-93 percent) were acceptable. Percent recoveries for BTEX spiked soil samples (82-93 percent) and water samples (98-108 percent) were within acceptable spike control limits. Percent recoveries of five VOC compounds and eleven PAH compounds were within acceptable spike control limits. Percent recovery for the PCB spiked soil sample (92 percent) was within the spike control limit range (64-133 percent). Percent recoveries for chromium (93 percent) and zinc (101 percent) were within acceptable spike control limits.

Laboratory Duplicates—The lab analyzed two pairs of samples in duplicate for each matrix (soil and ground water) in which one sample pair was spiked with a known amount of analyte(s). The relative percent difference (RPD) values calculated from the percent recoveries of the BTEX-spiked pair for soil (82-93 percent; 1.3-1.7 percent RPD) and for water (93-108 percent; 0.58-1.2 percent RPD) are acceptable. An RPD value for each BTEX compound was not calculated for the paired quality control samples in soil

and ground water since no BTEX compounds were detected above the method reporting limit in any of the samples.

The RPD values calculated from the percent recoveries of the diesel spiked pair for soil (84-87 percent; 0.24-1.4 percent RPD) and for water (91-93 percent; 2.3 percent RPD) are acceptable. RPD values were not calculated for paired quality control samples in soil and ground water since diesel was not detected above method reporting limits in any of the samples.

The RPD values calculated from the percent recoveries of the VOC compounds in the matrix spike/matrix spike duplicate (MS/MSD) analysis for soil (1.6-13 percent RPD) are considered acceptable. RPD values (1.5-22 percent) for eleven PAH compounds in the soil MS/MSD analysis are acceptable. The RPD value (4.9 percent) calculated from the percent recovery of Aroclor 1260 PCB in the soil MS/MSD analysis is considered acceptable.

The RPD value calculated from the percent recoveries of chromium and zinc in the quality control analysis (17 percent and 6.5 percent, respectively) and in the MS/MSD analysis (2.1 percent and 2.6 percent) are considered acceptable.

Results of Initial Site Investigation

Subsurface Conditions

Based on findings from the 15 probe borings drilled during this investigation, and from previous observations during tank closure assessment, the site primarily is underlain by alluvial deposits. The alluvial deposits generally consist of alternate layers of dark brown to black medium-grained sand overlying a clayey silt unit. The alternate sand/silt unit was encountered in all 15 borings, starting beneath the asphalt paving and extending to depths of approximately 7 to 9 feet. The base of this sand/silt unit was not reached.

Yellowish-colored petroleum product was noted in soil samples retrieved at 5 feet below ground surface in probe boring GP-5. Hydrocarbon-like odors were noted in soil samples retrieved from seven of the fifteen borings from above the water table. Ground water was encountered during drilling at all 15 boring locations, with water level depths of 6.5 to 7.5 feet.

Soil Analytical Results

Petroleum hydrocarbon analytical results of soil samples collected from probe borings are presented in Table 1 and illustrated in Figure 4. Results were compared to method A cleanup levels listed under the MTCA cleanup regulation (Washington Administration Code [WAC] Chapter 173-360).

Results indicate a heavy oil concentration of 130 mg/kg detected in the sample collected at the 7-foot interval in probe boring GP-12, located within the former waste oil tank excavation. This heavy oil concentration is below the MTCA method A soil cleanup level of 200 mg/kg. No other petroleum hydrocarbon constituents were detected above practical quantitation limits in any of the samples.

Table 1. Petroleum hydrocarbon results of soil samples collected from probe borings drilled at Federal Center South, Seattle, Washington (mg/kg).

| Sample Identification | Gasoline | Diesel | Heavy Oil | Benzene | Toluene | Ethylbenzene | Xylenes |
|--|----------|--------|-----------|---------|---------|--------------|---------|
| <i>MTCA method A cleanup level^a</i> | 100 | 200 | 200 | 0.5 | 40 | 20 | 20 |
| GP1 | (6.0) | — | — | (0.060) | (0.060) | (0.060) | (0.060) |
| GP7 | (5.7) | 68 | 170 | (0.057) | (0.057) | (0.057) | (0.057) |
| GP8 | (32) | — | — | (0.32) | (0.32) | (0.32) | (0.32) |
| GP10 | (6.3) | — | — | (0.063) | (0.063) | (0.063) | (0.063) |
| GP12 | — | (32) | 130 | — | — | — | — |
| GP13 | — | (32) | (63) | — | — | — | — |
| GP14 | — | (31) | (63) | — | — | — | — |

Refer to Figure 4 for sample locations.

Values reported in milligrams per kilogram (mg/kg) on a dry weight basis.

(6.0) Constituent not found above enclosed practical quantitation limit.

— Sample was not analyzed for this constituent.

^a MTCA—Model Toxics Control Act cleanup regulation (Department of Ecology publication 94-06, 1996).

Results of soil samples collected for waste oil parameters in borings GP-12 and GP-14 indicated methylene chloride concentrations of 0.28 mg/kg and 0.088 mg/kg, respectively. Methylene chloride, commonly used as a laboratory solvent, also was detected in the method blank, indicating the detection in the samples was due to laboratory contamination. No other VOC compounds, PAH compounds, or PCBs were detected above practical quantitation limits in either sample.

Both soil samples also were analyzed for the presence of chromium and zinc; the results are presented in Table 2 and illustrated in Figure 4. Low concentrations of both metals were detected in both samples, with neither result exceeding MTCA method A (for chromium) nor B (for zinc) cleanup levels.

Table 2. Metal results of samples collected from probe borings at Federal Center South, Seattle, Washington (mg/kg).

| Sample Identification and Depth | Chromium | Zinc |
|---------------------------------|------------------|---------------------|
| <i>MTCA soil cleanup levels</i> | 100 ^a | 96,000 ^b |
| GP12-7 | 6.5 | 23 |
| GP14-5 | 6.1 | 12 |

Values reported in milligrams per kilogram (mg/kg) on a dry weight basis.

^a Chromium cleanup level in soil as established in MTCA—Model Toxics Control Act method A cleanup regulation (Department of Ecology publication 94-06, 1996a).

^b Zinc cleanup level in soil as established in MTCA method B cleanup regulation (Department of Ecology publication 94-145, 1996b).

Ground Water Analytical Results

Petroleum hydrocarbon analytical results for ground water samples collected from probe borings are presented in Table 3 and illustrated in Figure 4. Results were compared to MTCA method A ground water cleanup levels.

Results indicate a benzene concentration of 13 µg/L detected in the water sample collected from probe boring GP-4, located 70 feet due west of the former dispenser island. This benzene concentration exceeds the MTCA method A cleanup level of 5 µg/L. Gasoline-range hydrocarbons (130 µg/L) and xylenes (1.2 µg/L) also were detected in GP-4, both below cleanup criteria. Benzene concentrations were detected in samples collected from probe borings GP-9 (3.7 µg/L) and GP-11 (2.5 µg/L), both below the regulatory cleanup criterion. No petroleum hydrocarbon constituents were detected above practical quantitation limits in samples collected from probe borings GP-3, GP-10, and GP-15.

Table 3. Petroleum hydrocarbon results of ground water samples collected from probe borings at Federal Center South, Seattle, Washington (µg/L).

| Sample Identification | Gasoline | Diesel | Heavy Oil | Benzene | Toluene | Ethylbenzene | Xylenes |
|--|----------|--------|-----------|-----------|---------|--------------|---------|
| <i>MTCA method A cleanup level^a</i> | 1,000 | 1,000 | 1,000 | 5.0 | 40 | 30 | 20 |
| GP3-W1 | (100) | — | — | (1.0) | (1.0) | (1.0) | (1.0) |
| GP4-W1 | 130 | — | — | 13 | (1.0) | (1.0) | 1.2 |
| GP9-W1 | (100) | — | — | 3.7 | (1.0) | (1.0) | (1.0) |
| GP10-W1 | (100) | — | — | (1.0) | (1.0) | (1.0) | (1.0) |
| GP11-W1 | (100) | — | — | 2.5 | (1.0) | (1.0) | (1.0) |
| GP15-W1 | — | (250) | (500) | — | — | — | — |

Refer to Figure 4 for sample locations.

Values reported in micrograms per liter (µg/L).

Results exceeding cleanup levels are printed in boldface type.

(100) Constituent not found above enclosed practical quantitation limit.

— Sample was not analyzed for this constituent.

^a MTCA—Model Toxics Control Act cleanup regulation (Department of Ecology publication 94-06, 1996).

Additional Soil Excavation

On April 14 and 15, 1999, E.P. Johnson Construction and Environmental, Inc. of Pasco, Washington conducted excavation activities at the Federal Center South site, including removal of petroleum-contaminated soil from the dispenser area and the area immediately west of the waste oil tank. Herrera Environmental Consultants, Inc. of Seattle, Washington performed oversight of removal activities. Excavation areas are shown in Figure 5. Photographs taken during excavation activities are presented in Appendix D. Weigh tickets for disposal of 416 tons of petroleum-contaminated soil by Remedco at the Waste Management Inc. facility in Seattle, are provided in Appendix E.

Dispenser Area Excavation

Excavation of the dispenser area located immediately south of former gasoline tank T8 was performed on April 14, 1999. The excavation area was identified and marked onsite immediately south of the former dispenser, based on results from the initial site investigation and tank removal observations. The asphalt paving first was saw-cut, removed, and stockpiled for disposal. The top 2 feet of soil beneath the asphalt paving was excavated and stockpiled onto plastic sheeting. This material was considered to be clean, since it came from near the surface and was downgradient of deeper sources. Observations during removal did not identify visual or odiferous indications of contamination. The soil eventually was placed back in the excavation along with clean imported backfill.

Soil removed from beneath the designated clean overburden was loaded directly onto trucks for removal offsite. Final excavation pit dimensions were approximately 35 feet by 38 feet, and approximately 7 feet deep (Figure 5). Ground water seeped into the excavation and stabilized at approximately 6.5 feet below ground surface. Soil consisted of slightly silty medium-grained sand and silt.

Waste Oil Tank Area Excavation

Removal of petroleum-contaminated soils at the former waste oil tank T7 location was performed on April 15, 1999. Asphalt paving was saw-cut, removed, and stockpiled for disposal. Final excavation pit dimensions were approximately 15 feet by 26 feet and approximately 7 feet deep (Figure 5). Ground water seeped into the excavation and stabilized at approximately 6.5 feet below ground surface. Soil removed from the waste oil area excavation was similar in lithology to soils removed from the dispenser area excavation. Further overexcavation on the east end of the pit was limited, due to the presence of the building wall and foundation.

Excavation Backfill Activities

Soon after petroleum-contaminated soils were excavated to the extent possible, both pit excavations first were lined with a non-woven geotextile filter fabric, and then backfilled with pea gravel from bottom to approximately 2 to 3 feet below ground surface. The filter fabric then was folded on top of the pea gravel. The overburden soil excavated from the dispenser area excavation was placed on top of the filter fabric/pea gravel backfill in that excavation. A layer of coarse crushed gravel base material was placed on top of the backfill material in both pit excavations, and then the surface was sealed with a 4-inch layer of asphalt.

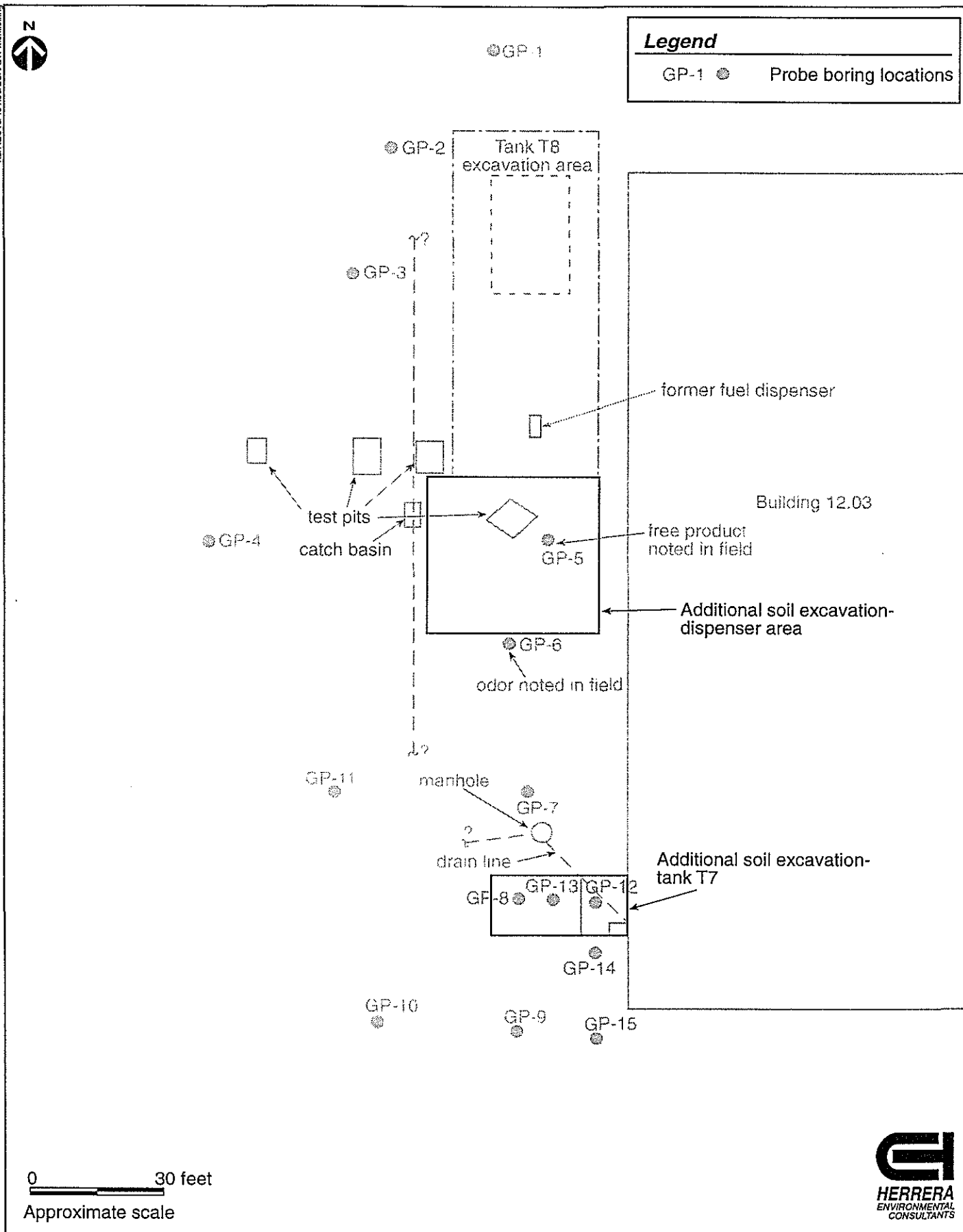


Figure 5. Areas of additional soil excavation near tanks T7 and T8 at Federal Center South, Seattle, Washington.

Monitoring Program Summary

In June and July 1999, following the excavation and removal of contaminated soil, further site characterization and a ground water monitoring program were initiated at the Federal Center South site. The purpose of the investigation was to characterize and determine the extent of petroleum hydrocarbon contamination of soil and ground water downgradient of the dispenser area and waste oil tank and to further define the ground water flow direction and gradient beneath the site. A ground water monitoring program was set up to track movement of contaminants over time. The work included:

- Drilling and installing seven ground water monitoring wells, FC-1 through FC-7
- Analysis of the ground water flow direction and gradient beneath the site
- Sampling of ground water at all seven wells for petroleum hydrocarbon constituents
- Monitoring and sampling ground water at all seven wells to evaluate ground water quality trends.

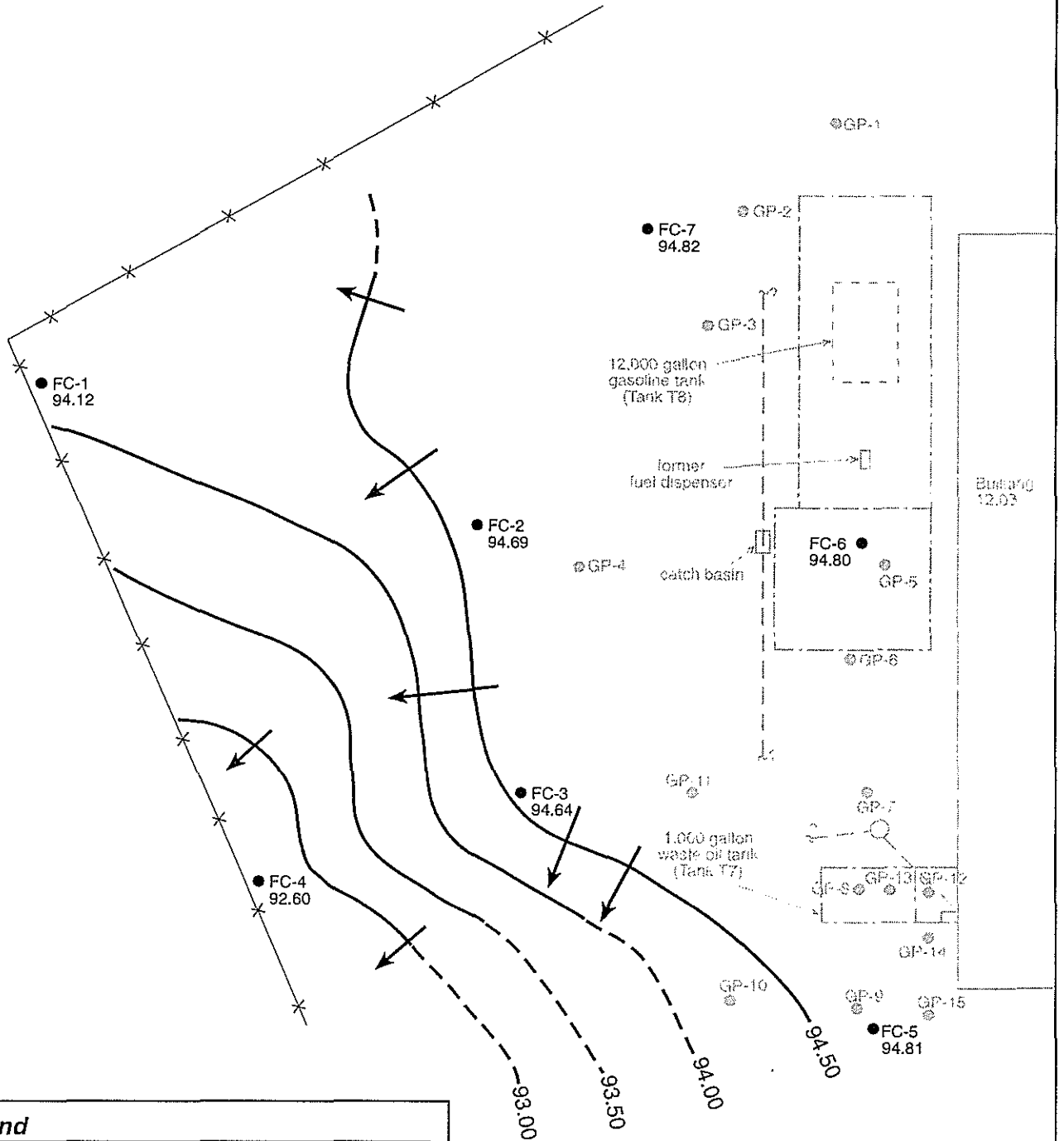
Appendix A presents a detailed description of field procedures, including sample collection and handling, drilling activities, monitoring well installation, and decontamination. Boring logs and well construction details are provided in Appendix B. Laboratory analytical reports for ground water samples are provided in Appendix F.

Drilling, well installation, and sampling activities were conducted on June 30 and July 1, 1999, and ground water samples were collected on July 6, 1999 by Herrera Environmental Consultants, Inc. Cascade Drilling, Inc. of Woodinville, Washington provided hollow-stem auger drilling and well installation services. OnSite Environmental Inc. of Redmond, Washington analyzed ground water samples for petroleum hydrocarbon constituents.

Sample Locations and Methods

Drilling and Well Installation

Seven ground water monitoring wells (FC-1 through FC-7) were drilled and installed at the Federal Center South site (Figure 6). Monitoring wells FC-1 through FC-4 were positioned west-southwest and downgradient of the estimated extent of petroleum hydrocarbon-contaminated ground water determined by previous investigations. Monitoring well FC-5 was positioned south of the waste oil tank area. Monitoring well FC-6 was positioned within the former dispenser area at the source of contamination. Monitoring well FC-7 was positioned to the northwest of the former gasoline tank location. Soil samples from each boring were collected



Legend

- FC-5 ● Monitoring well locations
- GP-1 ● Probe boring locations
- ↙ Estimated direction of ground water flow
- (94.12) Ground water surface elevations as measured on 07/06/99
- Ground water surface contour line
- - - Inferred ground water surface contour line

0 40 feet
Approximate scale



Figure 6. Water level contour map, July 6, 1999, Federal Center South, Seattle, Washington.

at 5-foot intervals using a decontaminated drive split-spoon sampler. Samples from each interval were visually classified for soil lithologies, screened for the presence of volatile organic compounds using a photoionization detector, and observed for moisture content indicating the presence of ground water. All seven borings were drilled and sampled to a total depth of 16.5 feet. Each boring was completed as a ground water monitoring well with a 10-foot screen section at the base, with each well installed at a total depth of 15 feet below ground surface. Each well was completed below grade in a watertight, traffic-rated well monument box. Ground water samples were collected from all seven monitoring wells on July 6, 1999, stored in chilled coolers, and then submitted to the laboratory for chemical analysis.

Sample Analyses

Samples collected during the initial ground water monitoring/sampling event were analyzed for petroleum hydrocarbon constituents by OnSite Environmental Inc. of Redmond, Washington using the following test methods:

- Total petroleum hydrocarbons in the gasoline-range (NWTPH-G) test method quantified against a gasoline-range hydrocarbon standard
- Benzene, toluene, ethylbenzene, and xylenes constituents (BTEX) using U.S. Environmental Protection Agency (U.S. EPA) 8020 test method.

In addition to these analyses, samples collected from wells FC-4, FC-5, and FC-6 were analyzed for the presence of diesel- and heavy oil-range hydrocarbons using Ecology's NWTPH-DX (extended) test method, quantified against diesel- and heavy oil-range hydrocarbon standards.

Complete laboratory analytical packages for ground water samples, including sample chain-of-custody forms, are included in Appendix F.

Data Quality Assurance Review

The analysis of seven ground water samples collected from wells FC-1 through FC-7 for TPH and BTEX analyses were determined to be acceptable for use based on the following criteria:

Method Blanks—There were no contaminants in the blanks detected above the instrument detection limit.

Surrogate Recoveries—All the undiluted samples had percent recoveries of surrogate compound fluorobenzene within the control limit range (50 to 150 percent recovery) for NWTPH-G and BTEX test methods, and o-terphenyl within the control limit range (50 to 150 percent recovery) for the NWTPH-DX test method.

Laboratory Control Spiked Samples—Percent recoveries of BTEX compounds in the MS/MSD analysis (90 to 93 percent recoveries) were within quality control limits.

Laboratory Duplicates—The RPD value (7.4 percent) calculated from the percent recovery of benzene in the quality control sample pair is acceptable. RPD values calculated from the percent recoveries of BTEX compounds in the spiked sample pair (0.24 to 1.0 percent RPD) are considered acceptable. An RPD value was not calculated from the diesel fuel quality control sample pair since no diesel-range hydrocarbons were detected above practical quantitation limits in either sample.

Laboratory Flags—The laboratory flagged the gasoline-range hydrocarbon concentration (500 µg/L) detected in samples collected from well FC-6 because the sample chromatogram does not match the chromatogram of the gasoline-range hydrocarbon standard. The lab identified the contaminant as either a weathered gasoline or diesel #1 fuel based on the sample chromatogram (OnSite 1999).

Results

Subsurface Soil Conditions

Based on findings from the seven well borings drilled during this investigation, and from 15 push probe borings and excavations conducted as part of previous investigations, the site primarily is underlain by alluvial deposits that generally consist of alternate layers of brown medium-grained sand and gray silt with variable amounts of clay and organic material. This alternate sand/silt unit is consistent with the soil lithology described from previous investigations as alluvial deposits. The sand/silt unit was encountered in all seven borings, starting immediately beneath the asphalt paving in five of the seven borings, and extending to the bottom depths of each boring at 16.5 feet. The base of the sand/silt unit was not reached in any of the borings. Crushed gravel fill material used to backfill the pit excavation, generated by excavating the contaminated soil within the dispenser area, was encountered overlying the sand/silt unit in boring FC-6, starting beneath the asphalt paving and extending to a depth of approximately 5 feet. Fill material also was encountered in boring FC-1, starting beneath the asphalt paving and extending to a depth of approximately 7 feet. Fill material in this boring consisted of coarse-grained sand with fine-grained gravel.

Hydrocarbon-like odors were noted in samples collected at the 5-foot interval retrieved from boring FC-6, positioned within the source area. No soil staining or hydrocarbon-like odors were noted in any samples retrieved from the remaining six borings. Photoionization detector readings above background levels were detected in samples collected from boring FC-1, ranging from 4.4 to 5.5 parts per million (ppm); boring FC-2, ranging from 4.8 to 8.8 ppm; boring FC-3, ranging from 7.2 to 14.5 ppm; and boring FC-6, ranging from non-detect to 21 ppm. No photoionization detector readings above background were detected in samples collected from borings FC-4, FC-5, or FC-7.

Site Ground Water Conditions—July 6, 1999

Ground water was encountered during drilling at all seven well boring locations at depths ranging from approximately 9 to 14 feet. Five days later, ground water was measured at depths ranging between 4.96 and 6.09 feet below reference elevation points at the top of each well casing (Table 4). Ground water elevation measurements collected from these wells indicate ground water flow direction is generally to the west-southwest, with an average hydraulic gradient of less than 0.01 feet per foot (Figure 6).

Table 4. Ground water surface elevation data collected on July 6, 1999 from monitoring wells at Federal Center South site, Seattle, Washington.

| Monitoring Well Identification | Reference Point Elevation ^a (feet) | Depth to Water ^b (feet) | Water Level Elevation (feet) |
|--------------------------------|--|---------------------------------------|---------------------------------|
| FC-1 | 99.23 | 5.11 | 94.12 |
| FC-2 | 100.59 | 5.90 | 94.69 |
| FC-3 | 100.73 | 6.09 | 94.64 |
| FC-4 | 98.65 | 6.05 | 92.60 |
| FC-5 | 100.29 | 5.48 | 94.81 |
| FC-6 | 99.76 | 4.96 | 94.80 |
| FC-7 | 100.00 | 5.18 | 94.82 |

^a Elevations of reference points (top of well casing) were surveyed relative to a temporary datum (well FC-7) with assigned elevation of 100.00 feet.

^b Depth to water measurements were taken from reference point marks on top of well casing.

Ground Water Analytical Results—July 6, 1999

Ground water samples were collected for chemical analysis from all seven wells on July 6, 1999. Analytical results for these samples are summarized in Table 5 and illustrated in Figure 7. Results are compared to method A cleanup levels for TPH and BTEX constituents listed in the Washington state Department of Ecology MTCA cleanup regulation (Ecology 1996a).

Analytical results indicate benzene (5.1 µg/L), ethylbenzene (91 µg/L), and xylenes (175 µg/L) present in ground water collected from well FC-2 at concentrations above the MTCA method A cleanup levels of 5 µg/L, 30 µg/L, and 20 µg/L, respectively. Gasoline-range hydrocarbons and toluene also were detected in well FC-2 at concentrations below the regulatory cleanup criteria. Other hydrocarbon constituents present at concentrations below the MTCA method A cleanup levels include benzene (3.5 µg/L) in well FC-3; heavy oil-range hydrocarbons (520 µg/L) in well FC-4; and gasoline-range hydrocarbons (500 µg/L), ethylbenzene (19 µg/L), and xylenes (9.4 µg/L) in well FC-6. No gasoline- and/or diesel- and heavy oil-range hydrocarbons or BTEX constituents were detected above practical quantitation limits in samples collected from FC-1, FC-5, and FC-7.

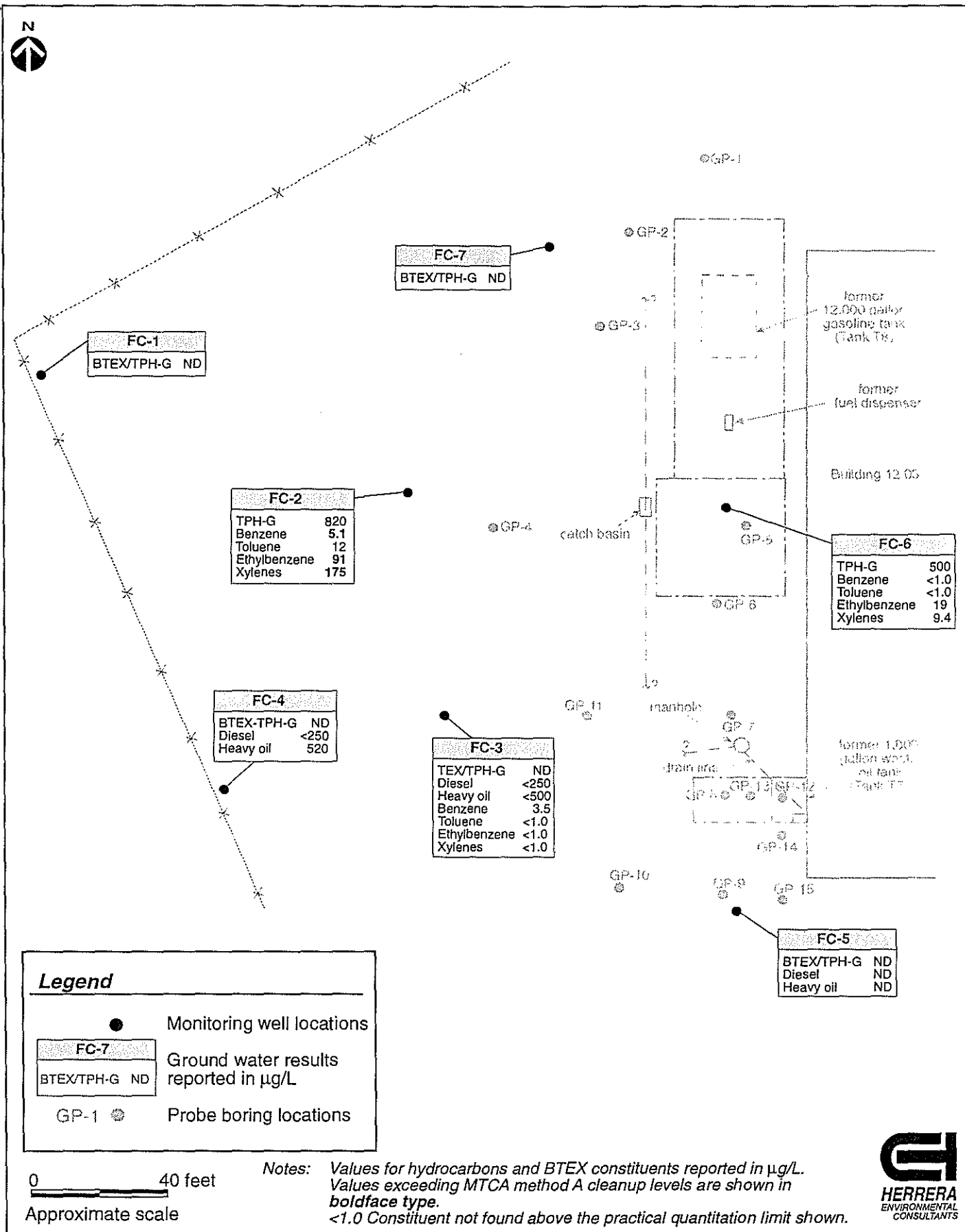


Figure 7. Petroleum hydrocarbon results for ground water samples collected on July 6, 1999 from wells at Federal Center South, Seattle, Washington.

Table 5. Petroleum hydrocarbons and BTEX results of ground water samples collected on July 6, 1999 from monitoring wells at the Federal Center South site (µg/L).

| Sample Identification | Gasoline Range Hydrocarbons | Diesel Range Hydrocarbons | Heavy Oil Range Hydrocarbons | Benzene | Toluene | Ethylbenzene | Xylenes |
|--|-----------------------------|---------------------------|------------------------------|------------|-----------|--------------|------------|
| <i>MTCA method A cleanup level^a</i> | <i>1,000</i> | <i>1,000</i> | <i>1,000</i> | <i>5</i> | <i>40</i> | <i>30</i> | <i>20</i> |
| FC-1 | (100) | — | — | (1.0) | (1.0) | (1.0) | (1.0) |
| FC-2 | 820 | — | — | 5.1 | 12 | 91 | 175 |
| FC-3 | (100) | (250) | (500) | 3.5 | (1.0) | (1.0) | (1.0) |
| FC-4 | (100) | (250) | 520 | (1.0) | (1.0) | (1.0) | (1.0) |
| FC-5 | (100) | (250) | (500) | (1.0) | (1.0) | (1.0) | (1.0) |
| FC-6 | 500 | — | — | (1.0) | (1.0) | 19 | 9.4 |
| FC-7 | (100) | — | — | (1.0) | (1.0) | (1.0) | (1.0) |

Values reported in micrograms per liter (µg/L).

(1.0) Indicates constituent not found above the enclosed practical quantitation limit.

— Sample was not analyzed for this constituent.

Values exceeding MTCA cleanup levels are shown in boldface type.

^a MTCA—Model Toxics Control Act cleanup regulation (Ecology 1996a).

Conclusions

A two-phase site investigation was conducted at Federal Center South to determine the extent of petroleum hydrocarbon contamination in soil and ground water associated with releases from two underground tank systems. Based on results of the initial site investigation, additional excavation and removal of contaminated soil from the dispenser area and waste oil tank location was performed. Seven monitoring wells were installed during the follow-up investigation as a basis for long-term ground water monitoring. Investigation results indicate the following:

- Gasoline contamination in excess of regulatory cleanup criteria detected in samples collected in the vicinity of the former dispenser area south of gasoline tank T8 appears to be the result of leakage from suction piping that ran approximately 15 feet between the fuel dispenser and the tank.
- Diesel and heavy oil contamination in excess of regulatory cleanup criteria found in soil surrounding the waste oil tank T7 most likely is a result of overfill and spillage.
- Ground water flow direction generally is to the west-southwest, with an average hydraulic gradient of less than 0.01 feet per foot (based on July 1999 ground water elevation data).
- Benzene, ethylbenzene, and xylenes contamination in ground water at well FC-2 exceeded MTCA method A cleanup levels. This well is positioned approximately 70 feet west of the former dispenser area. Samples collected from the remaining six wells either had petroleum contaminant concentrations below the MTCA method A cleanup levels, or had no hydrocarbon constituents detected above practical quantitation limits.

Ground water monitoring from the seven wells will continue on a quarterly basis for a period of three years, to further assess the effectiveness of the cleanup action performed at the site. The monitoring program will assess whether residual hydrocarbon-contaminated ground water in the vicinity of the dispenser area and waste oil tank location is migrating, and whether concentrations are decreasing. An assessment will be made after several additional monitoring events to determine whether further cleanup action or monitoring is required at this site.

References

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